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(54) [Title of the Invention] Apparatus for the Detection of Clogging of a Pipe

[57] [Abstract]

[Purpose]

To provide an apparatus which is capable of detecting clogging of a pressure conducting pipe, can improve the reliability of pressure detection and can be easily and simply maintained.

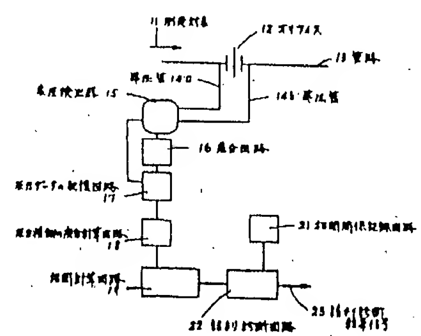
[Constitution]

An apparatus which is capable of detecting clogging of a pipe, which is equipped with 2 pressure conducting pipes, and a differential pressure



detecting means by which to detect a differential pressure and a static pressure through said pressure conducting pipes;

said apparatus for detecting clogging of a pressure conducting pipe characterized in that it is also equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation between the oscillation in the above- mentioned differential signal and the above- mentioned static pressure signal, and by which to generate a detection signal.



Key 11 object for measurement 12 orifice, 13 pipe, 14 a pressure conducting pipe, 14 b pressure conducting pipe, 15 differential pressure detecting device, 16 differential circuit, 17 memory circuit for pressure data, 18 circuit by which to calculate the degree of pressure oscillation, 19 correlation calculation circuit, 21 correlation recording circuit, 22 clogging diagnosis circuit, 23 clogging diagnosis state signal

[What we claim is]

[Claim 1]

An apparatus which is capable of detecting clogging of a pipe, which is equipped with 2 pressure conducting pipes, and a differential pressure detecting means by which to detect a differential pressure and a static pressure through said pressure conducting pipes;

said apparatus for detecting clogging of a pressure conducting pipe characterized in that it is also equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation between the oscillation in the above- mentioned differential signal and the above- mentioned static pressure signal, and by which to generate a detection signal.

[Claim 2]

An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation



among the width of oscillation of the differential pressure value, and the width of oscillation of the static pressure value in a case in which the pressure value at the high pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the low pressure side which is to be obtained by deducting the differential pressure value from the static pressure value or the width of oscillation of the differential pressure value and the width of oscillation of the static pressure value in a case in which the pressure value at the low pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the high pressure side which is to be obtained by adding the differential pressure value to the static pressure value, and by which to generate a detection signal.

[Claim 3]

An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the difference

between the degree of oscillation of the pressure value on the high pressure side, and the degree of oscillation of the pressure value on the low pressure side, the difference between the degree of oscillation of the pressure value at the high pressure side and the degree of oscillation of the differential pressure value, and the difference between the degree of oscillation of the pressure value on the low pressure side and the degree of oscillation of the differential pressure value.

[Detailed Explanation of the Invention]

[0001]

[Utilization Fields in the Industry]

The present invention relates to an apparatus which is capable of detecting clogging of a pressure conducting pipe, can improve the reliability of pressure detection and can be easily and simply maintained.

[0002]

[Conventional Technology]

In Fig. 12 is shown a drawing by which to explain the constitution of a



conventional example which has generally been used for many years. For example, it is shown in "Kogyo Keisoku Handbook (Handbook of Industrial Instrumentation)" (Volume on Pneumatic Instrumentation), edited by Yokokawa Electric Co., Ltd., published by Tokyo Electric College Publication, date published December 10, 1966, page 2, Fig. 1. 3.

[0003]

In Fig. 12, 1 is a pipe through which a fluid to be measured 2 flows. 3 is a valve by which to control the flow volume of the fluid to be measured, and 4 is a positioner by which to control the degree of opening of the valve 3. 5 is a controller by which to control a positioner 4. 6 denotes a flow meter body by which to detect the flow volume of the fluid to be measured which has been controlled by the valve 3 and to send a detection signal to the controller 5. And in this case, use is made of a differential pressure transmitter. 7 is a pressure conducting pipe by which to transmit the pressure of the fluid to be measured 2 to the flow meter body 6. 8 is an orifice.

[0004]

In the above- mentioned constitution, when a fluid to be measured 2 flows through the pipe 1, the flow meter body 6 measures the flow volume of the fluid to be measured 2. The signal of the measurement of the flow volume from the flow meter body 6 is sent to the controller 5, where it is compared with a target value, an adjustment signal is sent to the valve positioner 4, and thus the valve 3 may be opened or closed.

[0005]

[Tasks which the Invention Tries to Solve]

However, with such an apparatus, even if the pressure conducting pipe 7 is clogged and some abnormality takes place in the pressure conducting pipe 7, it is difficult to detect the abnormality in many cases, although it is possible to detect such an abnormality in a case in which there takes place a large variation to the extent that the output of the flow meter body 6 reaches the limit of a meter or beyond, or in a case in which an inspection such as a regular inspection is carried out. In order to prevent these abnormalities from taking place before the generation of an output



abnormality, it is necessary to predict it from a variation in output in an empirical manner, or to find a clogging state in a regular inspection by an operator, etc. In view of safety, it is necessary to have frequent regular inspections, and frequent inspections have problems of requiring time and labor. In addition, there has been a problem in that it can not cope with sudden clogging. The present invention has been achieved in order to solve the above- mentioned problems of the conventional technology. The purpose of the present invention is to provide a differential pressure measuring apparatus which is capable of constantly observing a clogging state of a pressure conducting pipe and can sound an alarm in a case in which the clogging in a pressure conducting pipe exceeds a pre-determined level. That is, the purpose of the present invention is to provide an apparatus which is capable of detecting clogging of a pressure conducting pipe, can improve the reliability of pressure detection and can be easily and simply maintained.

[0006]

[Means by which to Solve the Task]

In order to achieve this purpose, in the present invention; the following apparatuses are constituted :

(1) An apparatus which is capable of detecting clogging of a pipe, which is equipped with 2 pressure conducting pipes, and a differential pressure detecting means by which to detect a differential pressure and a static pressure through said pressure conducting pipes;
said apparatus for detecting clogging of a pressure conducting pipe characterized in that it is also equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation between the oscillation in the above- mentioned differential signal and the above- mentioned static pressure signal, and by which to generate a detection signal.

(2) An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation among the width of oscillation of the differential pressure value, and the



width of oscillation of the static pressure value in a case in which the pressure value at the high pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the low pressure side which is to be obtained by deducting the differential pressure value from the static pressure value or the width of oscillation of the differential pressure value and the width of oscillation of the static pressure value in a case in which the pressure value at the low pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the high pressure side which is to be obtained by adding the differential pressure value to the static pressure value, and by which to generate a detection signal.

(3) An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the difference between the degree of oscillation of the pressure value on the high pressure side, and the degree of oscillation of the pressure value on the

low pressure side, the difference between the degree of oscillation of the pressure value at the high pressure side and the degree of oscillation of the differential pressure value, and the difference between the degree of oscillation of the pressure value on the low pressure side and the degree of oscillation of the differential pressure value.

[0007]

[Actions]

In the above- mentioned constitution, by use of a differential pressure detecting means, a differential pressure and a static pressure are detected through the pressure conducting pipes. In the detecting means, from the correlation between the oscillation of a differential pressure signal detected by the differential pressure detecting means and the oscillation of a static pressure signal, a clogging state of one of the pressure conducting pipes or clogging states of both of the pressure conducting pipes is/ are detected, and a detection signal is generated. In the following, we shall give a detailed explanation based on some examples embodying the present invention.



[0008]

{Examples Embodying the Invention]

Fig. 1 is a constitution diagram which shows one example embodying the present invention. In this drawing, 11 is an object for the measurement, and for example, it offers a pressure oscillation of about $\pm$ 300 mm Hg with 10 kg f/ cm $^2$ as a center. 12 is an orifice which is provided in the pipe path 13. 14 a and 14 b are pressure conducting pipes of an inner diameter of about 15 mm, in this case, by which to conduct the pressure from the object for measurement 1. 15 is a differential pressure detecting device which is connected to one end each of the pressure conducting pipes 14, and detects a static pressure value and a differential pressure value. Here as a static pressure, a pressure on the high pressure side is considered to be a static pressure since a pressure $P_H$ on the high pressure side is made to be a static pressure according to the rule of the JIS.

[0009]

16 is a differential circuit to which the output of the pressure detecting means 3 is to be input, and it is a differential circuit which calculates a

pressure value on the low pressure side $P_L$ by subtracting the differential pressure from the static pressure value. The pressure value on the low pressure side $P_L$ is a pressure which is conducted from the pressure conducting pipe 14 b. 17 is a memory circuit of pressure data by which to keep, for a certain period of time, a pressure value on the low pressure side $P_L$ which has been calculated by the differential circuit 16, a pressure difference value which has been detected by the pressure detecting means 3, and a static pressure value (pressure value on the high pressure side $P_H$). 18 is a circuit for the calculation of the degree of oscillation by which to calculate the degree of oscillation in each pressure from the pressure data kept in the memory circuit 17. 19 is a correlation calculating circuit by which to calculate, by a pre- determined method, the correlation of the degrees in oscillation of the various pressure values calculated by the calculating circuit 18 for the degree of oscillation in pressure. 21 is a correlation recording circuit by which to record a value which indicates the correlation at the time when a pressure conducting pipe is clogged. 22 is a diagnosis circuit for clogging by which to



compare the value indicating the correlation which is to be output from the correlation calculating circuit 19, and the recorded value of the correlation recording circuit 21, and to calculate the clogging state / states of the pressure conducting pipes 14 a and 14 b. In this case, the clogging state is directly diagnosed from the correlation between the oscillation in differential pressure signal and the oscillation in static pressure signal. 23 is a clogging diagnosis result signal which is to be output from the clogging diagnosis circuit 22. In the above- mentioned constitution, the differential pressure detecting means 15 detects the differential pressure values of an object for measurement 11 transmitted from the pressure conducting pipes 14 a and 14 b, and the static pressure value ( pressure value on the high pressure side $P_H$). The pressure value on the low pressure side $P_L$ is calculated from the pressure values thus detected. As to the differential pressure value, the static pressure value (pressure value on the low pressure side $P_H$ ), and the pressure value on the low pressure side $P_L$, all the pressure data measured for a certain period of time are maintained in the memory circuit 17 for

pressure data. The calculation circuit 18 for the degree of oscillation in pressure utilizes the data kept in the memory circuit 17 for the pressure data to calculate the degree of oscillation in each pressure. The correlation calculation circuit 7 calculates, by a pre- determined method, the correlation of the degree of oscillation in each pressure output from the calculation circuit for the degree of oscillation in pressure 18, and outputs it to the clogging diagnosis circuit 22. The clogging diagnosis circuit 22 compares the correlation of each mode of the pressure conducting pipes 14 a and 14 b (clogging on both sides of the high pressure side and the low pressure side, and one side clogging of them) maintained in advance in the correlation recording circuit 21, carries out diagnosis of a clogging state / states, for example, by a method such as a fuzzy inference method, and outputs a result of the diagnosis by a pre-determined method. Let us further give a detailed discussion. From the following correlation between a differential pressure value and a static pressure value, it becomes possible to presume clogging of a pressure conducting pipe. In general, in a case in which an orifice type flow



volume measurement is being made, the values of the static pressure and the differential pressure are not constant, and they always have oscillation portions. (Since the static pressure at this time generally denotes a pressure on the high pressure side, we shall regard a pressure at the high pressure side as a static pressure here. Even if a pressure at the low pressure side is made to be a static pressure, we can think this in a similar manner.)

Therefore, if the oscillation widths of a differential pressure and a static pressure are small in comparison with the oscillation width of a differential pressure and that of a static pressure under a state in which no clogging is taking place in pressure conducting pipes at the high pressure side and the low pressure side, it is presumed that both pressure conducting pipes on the high pressure side and the low pressure side are both clogged. In addition, a differential pressure transmitting device is in general sufficiently separated from a variation in static pressure in order to generate a differential pressure output under whatsoever condition or environment. However, in a case in which either of a pressure conducting

pipe on the high pressure side or a pressure conducting pipe on the low pressure side is clogged, since a differential pressure value which is affected by a pressure variation of a static pressure due to the clogging is applied to the differential pressure transmitting device, there appears a variation which has a certain correlation between an oscillation portion in differential pressure and an oscillation portion in static pressure just prior to or after the generation of such clogging. We shall show this below. In the first place, we shall consider a case in which there is no large pulsating pressure variation in static pressure and differential pressure due to a plunger pump, etc. Therefore, oscillation in differential pressure or static pressure is a random pressure variation which is caused by a turbulent flow generated by the orifice, and it is assumed that the phases in oscillation of them do not coincide with each other. The correlations can be broadly classified by the magnitude in oscillation of a differential pressure and in oscillation of a static pressure in a case in which both high pressure side and low pressure side are not clogged. In the following, what becomes an object for standard for the comparison of oscillation



widths is a width in oscillation in a case in which the pressure conducting pipes are not clogged at both high pressure side and low pressure side.

1) At the time when the width in oscillation of a static pressure is large to a considerable degree compared with the width in oscillation of a differential pressure :

a) In a case in which both pressure conducting pipe on the high pressure side and pressure conducting pipe on the low pressure side are clogged,

...both oscillation in differential pressure and oscillation in static pressure become small.

b) In a case in which only a pressure conducting pipe on the high pressure side is clogged,

...the width in oscillation of a static pressure becomes small, and the width in oscillation of a differential pressure becomes large.

c) In a case in which only a pressure conducting pipe on the low pressure side is clogged,

...a differential pressure and a static pressure become equal in magnitude and phase in oscillation thereof. That is, the width in oscillation of the

differential pressure becomes large and the width in oscillation of the static pressure does not vary.

2) At the time when the width in oscillation of a static pressure is approximately equal to the width in oscillation of a differential pressure :

a) In a case in which both pressure conducting pipe on the high pressure side and pressure conducting pipe on the low pressure side are clogged,

...both oscillation in differential pressure and oscillation in static pressure become small.

b) In a case in which only a pressure conducting pipe on the high pressure side is clogged,

...the width in oscillation of a static pressure becomes small, and the width in oscillation of a differential pressure remains unchanged.

c) In a case in which only a pressure conducting pipe on the low pressure side is clogged,

...a differential pressure and a static pressure become equal in magnitude and phase in oscillation thereof. That is, the width in oscillation of the



differential pressure becomes small and the width in oscillation of the static pressure does not vary.

Next, let us consider a case in which a pulsating pressure variation is included in a static pressure and a differential pressure. As described above, in a case in which only one of the pressure conducting pipes is clogged, a variation in pressure on the side where no clogging has taken place becomes equal to a variation in differential pressure value. That is, in a case in which the low pressure side is clogged, a variation in pressure on the high pressure side becomes equal to a variation in differential pressure in both magnitude and phase. In a case in which only the high pressure side is clogged, a variation in pressure on the low pressure side becomes equal to a variation in differential pressure in magnitude, and the directions in variation become opposite to each other. Therefore, the following correlation appears, and clogging can be presumed.

Let us consider a case in which there is a large pulsating pressure variation in static pressure.

a) In a case in which only the pressure conducting pipe on the high

pressure side is clogged,

...there disappears the pulsating pressure variation of a static pressure, and that pulsating variation appears in a differential pressure.

b) In a case in which only the pressure conducting pipe on the low pressure side is clogged,

...in synchronization with the pulsating pressure variation of a static pressure, a similar pulsating variation appears in the differential pressure. That is, the pulsating pressure variation of the static pressure does not undergo any change, and that pulsating variation appears in the differential pressure.

As mentioned above, from the correlation between oscillation (pulsation) of a static pressure and that of a differential pressure, clogging of a pressure conducting pipe can be presumed. The results of actual measurements of flow volumes are shown in Fig. 2, Fig. 3 and Fig. 4. The a figures show a differential pressure output, and the b figure a static-pressure output. The ordinate indicates a pressure value, while the abscissa is a time axis with data numbers measured in a dispersed



manner. In all the drawings, approximately data No. 1 through data No. 500 show pressure variations in a state in which there is no clogging in a pressure conducting pipe, and data No. 501 through data No. 1000 show variations in output at the time when clogging is generated in a pressure conducting pipe in a quasi manner. The flow volume state measured corresponds to the case 1) mentioned above in which the oscillation of a static pressure is large in comparison with that of a differential pressure. If clogging is allowed to take place in the pressure conducting pipes at both high pressure side and low pressure side, it becomes as shown in Fig. 2, and both static pressure and differential pressure become small in width in oscillation. When clogging is allowed to take place only in the pressure conducting pipe on the high pressure side, as shown in Fig. 3, the width in oscillation of a differential pressure becomes large while that of oscillation of a static pressure becomes small. If clogging is allowed to occur only in the pressure conducting pipe on the low pressure side, as shown in Fig. 4, the oscillation of a static pressure becomes almost equal to that of a differential pressure, and therefore, in this case, the width in

oscillation of a differential pressure becomes large. Furthermore, although the above explanation has been given by dividing the correlations into the one for which there is pulsation, and the one without pulsation, there are many cases in reality in which these are mixed. In such a case, clogging may be presumed by making judgment, paying attention to a variation where there is no pulsation, and by making judgment, paying attention to pulsation. As a result of this, it becomes unnecessary to carry out a regular inspection of a clogging state of a pressure conducting pipe path, and it becomes possible to reduce the work units for maintenance. In addition, since it becomes possible to made a diagnosis of clogging at a time necessary to an extent necessary, the reliability of a measurement of pressure improves. In addition, it has been necessary to have a many years' experience in order to presume a clogging state of a pressure conducting pipe due to an abnormal output of a pressure measuring apparatus, but when use is made of the apparatus in accordance with the present invention, it becomes possible for anyone to make a diagnosis. Fig. 5 is a drawing by which to explain the



constitution of the main section of another example embodying the present invention. In this example embodying the present invention, 31 denotes a clogging diagnosis circuit by which to compare a value which indicates a correlation output from the correlation calculation circuit 19 and a recorded value of the correlation recording circuit 21, and by which to calculate a clogging state / states of the pressure conducting pipes 14 a and 14 b. In this case, from the correlation among the width of oscillation of a differential pressure signal, and the width of oscillation of a static pressure signal obtained from the pressure value at the high pressure side , and the width of oscillation of the pressure values on the low pressure side which is to be obtained by subtracting the differential pressure value from the static pressure value, a clogging state / states of one or both of the pressure conducting pipes, and a detection signal is generated. As a result of this, by obtained the difference between differential pressure value and the static pressure value, it becomes possible to clarify clogging of the pressure conducting pipe on the low pressure side which is not clear in the example embodying the present

invention which is shown in Fig. 1. That is, that "the oscillations of both differential pressure and static pressure become equal in both magnitude and phase" can be expressed by the fact that the absolute value of "static pressure - differential pressure" or "differential pressure - static pressure" becomes small. From this fact, it becomes possible to make a diagnosis more simply and more accurately in predicting clogging. In reality, the results of calculations of "static pressure - differential pressure (pressure due to clogging on the low pressure side) based on the results of the measurements shown in Fig. 2, Fig. 3 and Fig. 4 are shown in Fig. 6 (a), (b) and (c). Fig. 6 (a), (b) and (c) are respectively calculated from the static pressure values and differential pressure values shown in Fig. 2, Fig. 3 and Fig. 4. If clogging takes place in the pressure conducting pipe at the low pressure side, the width of ocsillation becomes small as shown in Fig. 6 (c), and this it becomes possible to presume that clogging has taken place. Fig. 7 is a drawing by which to explain the constitution of the main section of another example embodying the present invention. In this example embodying the present invention, 41 denotes a clogging



diagnosis circuit by which to compare a value which indicates a correlation output from the correlation calculation circuit 19 and a recorded value of the correlation recording circuit 21; and by which to calculate a clogging state / states of the pressure conducting pipes 14 a and 14 b. In this case, from the value obtained by subtracting the degree of oscillation of a pressure value at the low pressure side from the degree of oscillation of the pressure values on the high pressure side, and the value obtained by subtracting the degree of ocsillation of the differential pressure value from that of oscillation of the pressure value at the high pressure side, and the value obtained by subtracting the degree of ocsillation of the differential pressure from that of ocsillation of the pressure value at the low pressure side, a clogging state / states of one or both of the pressure conducting pipes, and a detection signal is generated. As a result of this, in a case in which clogging in a pressure conducting pipe is actually presumed, if only a variation of the width in oscillation is presumed, depending on a flow volume condition being measured, the widths in oscillation of the differential pressure and the static pressure

vary, and there is a possibility to presume that even though not clogged in reality, clogging is presumed. In addition, in order to avoid this, various conditions must be attached to the correlation, and it becomes complicated to presume clogging. Therefore, if the following signal processing is carried out, presumption can be more simply made.

1) The width of the oscillation of a differential pressure output, that of the oscillation of a static pressure (pressure on the high pressure side) output and that of the oscillation of a (static pressure - differential pressure (pressure at the low pressure side)) output, $D_{pb}$, $S_{pb}$ and $P_{Lb}$, are calculated, and differences of them are taken. For example, by utilizing parameters Q, R and S which are calculated by $Q = S_{pb} - P_{Lb}$, $R = P_{Lb} - D_{pb}$ and $S = S_{pb} - D_{pb}$, it is possible to cancel out a variation on width of oscillation due to a variation in flow volume.

a) A case in which the pressure conducting pipes on both high pressure side and low pressure side are clogged :

Since $S_{pb}$, $D_{pb}$, and $P_{Lb}$ all become small, Q, R and S all become small.

b) A case in which the pressure conducting pipe on the high pressure



side is clogged :

Since $S_{pb}$ becomes small, the value of Q becomes negative, and since $D_{pb}$ can assume a certain value by a variation in pressure at the low pressure side, the value of S also becomes negative. If $P_{Lb}$ is compared with $D_{pb}$, since $D_{pb}$ is generated by the oscillation in pressure on the low pressure side, R assumes a value close to 0.

c) A case in which the pressure conducting pipe on the low pressure side is clogged :

Since $P_{Lb}$ becomes small, Q increases, and since $D_{pb}$ assumes a certain value due to the variation in pressure on the high pressure side, R assumes a negative value. If one compares $S_{pb}$ and $D_{pb}$, S assumes a value close to zero because $D_{pb}$ is generated from the oscillation in pressure at the high pressure side.

The results of the actual measurements are shown in Fig. 8, Fig. 9 and Fig. 10. The flow speed becomes slower in the sequence of Fig. 8, Fig. 9 and Fig. 10, the static pressure becomes higher, and the flow volume conditions change. How to look at the graphs shown in the drawings is

the same as that in the case of Fig. 1. (a), (b) and (c) shown in the drawings correspond to (a), (b) and (c) shown in Fig. 6. In addition, (R) in (b) in Fig. 8, Fig. 9 and Fig. 10 and (S) in (c) in Fig. 8, Fig. 9 and Fig. 10 are not zero in a strict sense and assume positive values, it is considered that this is due to the fact that because of the structure of the center diaphragm of the transmitting device used in the experiment, in the case of (b) of Fig. 8, Fig. 9 and Fig. 10, a variation in pressure on the low pressure side is transmitted to the high pressure side through the center diaphragm, and the oscillation in differential pressure becomes small to some extent compared with the oscillation of the pressure on the low pressure side. The case of (c) of Fig. 8, Fig. 9 and Fig. 10 can be similarly explained. Fig. 11 is a drawing by which to explain the constitution of the main section of another example embodying the present invention. In this example embodying the present invention, 51 denotes a clogging diagnosis circuit by which to compare a value which indicates a correlation output from the correlation calculation circuit 19 and a recorded value of the correlation recording circuit 21, and by which



to calculate a clogging state / states of the pressure conducting pipes 14 a and 14 b. In this case, differences are obtained between a pressure value at a certain time and a pressure value at one prior time with respect to the differential pressure, the static pressure and the pressure value on the low pressure side obtained by subtracting the differential pressure from the static pressure, an appropriate combination is taken out from the combinations of the products, the quotients, the sums, and the differences of these values of the differences with these 3 differences as parameters, and thus a clogging state /states of one or both of the optimal pressure conducting pipes is/ are detected, thereby generating a detection signal/ signals. As a result, it becomes possible to detect a clogging state / states of one or both of the optimal pressure conducting pipes.

Specifically, the differential pressure values and the static pressure values measured in a dispersed manner are utilized as follows;

a. First, the differential pressure is subtracted from the static pressure, and a pressure value on the low pressure side is calculated.

b. A difference from one previous pressure value is taken. For

example, let us assume that the pressure values at one time are DP n, SP n and PL n, and that the pressure values at one previous time are DP n -1, SP n -1, and PL n -1, and then we calculate the differences, dDP n = DP n - DP n -1, dSP n = SP n - SP n -1, and dPL n = PL n - PL n -1.

c: By using parameters dDP n, DSP n and dPL n, the correlations of DP, SP and PL are obtained, and a clogging state is presumed.

Here when presuming a clogging state by use of these parameters, we utilize the following characteristics.

a) When the pressure conducting pipes both on the high (H) side and the low (L) side are clogged, the oscillation of a pressure becomes small. (The absolute values of dDP n, dSP n and dPL n become small.)

b) If the pressure conducting pipe on the L side is clogged, the oscillation of the differential pressure output becomes to coincide with that of the static pressure output (dDP n ≒ dSP n, |dDP n| ≒ |dSP n|), and the oscillation of the pressure on the low pressure side become small. (The absolute value of dPL n becomes small.)

c) If the pressure conducting pipe on the H side is clogged. the



oscillation of the differential pressure output becomes to coincide with the negative value of the oscillation of the output on the low pressure side (dDP n ≒ - dPL n, |dDP n| ≒ |dPL n|).

The oscillation of the static pressure side become small. (The absolute value of dSP n becomes small.)

1: By multiplying each other, each parameter has the following meaning.

dDP n x dSP n : If there is a tendency that it assumes a positive sign, it indicates that dDP n and dSP n have the same sign, and it may be presumed from b) that there has been caused a clogging state in the pressure conducting pipe on the L side. In addition, if the absolute value becomes small, it is indicated from a) that the oscillation of either DP or SP has become small, and it may be presumed that both H side and L side have been clogged or the H side has been clogged.

dDP n x dPL n : If there is a tendency that it assumes a negative sign, it indicates that the sign of dDP n is opposite to that of dPL n, and from c) it may be assumed that clogging has taken place in the pressure conducting pipe on the H side. In addition, if the absolute value becomes small, it

may be indicated from a) that the oscillation of either DP or PL has become small, and it may be presumed that both H side and L side have been clogged or the L side has been clogged.

dSP n x dPL n : If the absolute value becomes small, since it is indicated from a) that the oscillation of either DP and PL has become small, it may be presumed that both H side and L side have been clogged or either H side or L side has been clogged.

2. By dividing each other, each parameter has the following meaning.

dSP n / dDP n : If there is a tendency that it assumes a positive sign and the absolute value thereof approaches 1, it indicates that the magnitudes and signs of both dSP n and dDP n are equal to each other, and it may be presumed from b) that clogging has been caused in the pressure conducting pipe on the L side. If the absolute value becomes small, it indicates that dSP n has become small, and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the H side.

dDP n / dSP n : If there is a tendency that it assumes a positive signa and



the absolute value thereof approaches 1, it indicates that the magnitudes of dDP n and dSP n are equal to each other and the signs thereof are also equal to each other, and from b), it may be presumed that there has been caused clogging in the pressure conducting pipe on the L side. If the absolute value becomes large, it indicates that dSP n has become small and from a), it may be presumed that clogging has been caused in the pressure conducting pipe on the H side.

dPL n / dDP n : If it assumes a negative sign and there is a tendency that the absolute value thereof approaches 1, it indicates that the magnitudes of dPL n and dDP n are equal to each other and the sign of dPL n is opposite to that of dDP n, and it may be presumed from c) that clogging has been caused in the pressure conducting pipe on the H side. If the absolute value becomes small, it indicates that the magnitude of dPL n has become small and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the L side.

dDP n / dPL n : If it assumes a negative sign and there is a tendency that the absolute value thereof approaches 1, it indicates that the

magnitudes of dPL n and dDP n are equal to each other and the sign of dPL n is opposite to that of dDP n, and it may be presumed from c) that clogging has been caused in the pressure conducting pipe on the H side. If the absolute value becomes large, it indicates that the magnitude of dPL n has become small and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the L side.

dSP n / dPL n : If the absolute value thereof becomes large, it indicates that dPL n has become small, and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the L side. If the absolute value becomes small, it indicates that the magnitude of dSP n has become small and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the H side.

dDP n / dPL n : If the absolute value thereof becomes large, it indicates that dSP n has become small, and it may be presumed from a) that clogging has been caused in the pressure conducting pipe on the H side. If the absolute value becomes small, it indicates that the magnitude of dPL n has become small and it may be presumed from a) that clogging



has been caused in the pressure conducting pipe on the L side.

3. By adding each, each parameter has the following meaning :

dDP n + dSP n : If the absolute value increases, it indicates a tendency that the signs of dDP n and dSP n coincide with each other, and it may be presumed from b) that clogging has been caused in the pressure conducting pipe on the L side.

dDP n + dPL n : If the absolute value decreases, it indicates a tendency that the signs of dDP n and dSP n are opposite , and it may be presumed from c) that clogging has been caused in the pressure conducting pipe on the H side.

4. By subtracting each, each parameter has the following meaning :

dDP n - dSP n : If the absolute value decreases, it indicates that the magnitudes of dDP n and dSP n are equal to each other and the signs thereof are equal to each other, and it may be presumed from b) that clogging has been caused in the pressure conducting pipe on the L side. In addition, if the absolute value increases, since it indicates that the oscillation of SP has become small, it may be presumed from a) that there

has been clogging on the H side.

dSP n - dDP n : If the absolute value decreases, it indicates that the magnitudes of dDP n and dSP n are equal to each other and the signs thereof are equal to each other, and it may be presumed from b) that clogging has been caused in the pressure conducting pipe on the L side. In addition, similarly, since it indicates that the oscillation of SP has become small, it may be presumed from a) that there has been clogging on the H side.

dDP n - dPL n : If the absolute value increases, it indicates a tendency that the signs of dDP n and dPL n are opposite, and it may be presumed from c) that clogging has been caused in the pressure conducting pipe on the H side. In addition, if the absolute value decreases, since it indicates that the oscillation of PL has become small, it may be presumed from a) that there has been clogging on the L side.

dPL n - dDP n : If the absolute value increases, it indicates a tendency that the signs of dDP n and dPL n are opposite, and it may be presumed from c) that clogging has been caused in the pressure conducting pipe on



the H side. In addition, similarly , since it indicates that the oscillation of PL has become small, it may be presumed from a) that there has been clogging on the L side.

It is possible to make an appropriate diagnosis on clogging of a pressure conducting pipe /pipes by combining the parameters given in 1 through 4 described above. For example, if one utilizes the 3 parameters of dDP n x dSP n, dDP n x dPL n, and dSP n x d PL n, we may make a diagnosis as follows:

(1) dDP n x dSP n > 0 and |dSP n x dPL n| and |dDP n x dPL n| decrease ---> clogging is caused in the pressure conducting pipe on the L side

(2) dDP n x dPL n < 0 and |dDP n x dSP n| and |dSP n x dPL n| decrease ---> clogging is caused in the pressure conducting pipe on the H side

(3) dDP n x dSP n, dDP n x dPL n, and dSP n x dPL n all decrease ---> clogging is caused in the pressure conducting pipes both on the L side and the H side.

[0010]

[Effects of the Invention]

As explained above, the present invention has constituted the following pipe clogging detection apparatus:

(1) An apparatus which is capable of detecting clogging of a pipe, which is equipped with 2 pressure conducting pipes, and a differential pressure detecting means by which to detect a differential pressure and a static pressure through said pressure conducting pipes;

said apparatus for detecting clogging of a pressure conducting pipe characterized in that it is also equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation between the oscillation in the above- mentioned differential signal and the above- mentioned static pressure signal, and by which to generate a detection signal.

(2) An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the correlation among the width of oscillation of the differential pressure value, and the



width of oscillation of the static pressure value in a case in which the pressure value at the high pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the low pressure side which is to be obtained by deducting the differential pressure value from the static pressure value or the width of oscillation of the differential pressure value and the width of oscillation of the static pressure value in a case in which the pressure value at the low pressure side is made to be a static pressure, and the width of oscillation of the pressure values on the high pressure side which is to be obtained by adding the differential pressure value to the static pressure value, and by which to generate a detection signal.

(3) An apparatus for detecting clogging of a pressure conducting pipe, in accordance with Claim 1, characterized in that it is equipped with a detecting means by which to detect a clogging state / states of one or both of the above- mentioned pressure conducting pipes from the difference between the degree of oscillation of the pressure value on the high pressure side, and the degree of oscillation of the pressure value on the

low pressure side, the difference between the degree of oscillation of the pressure value at the high pressure side and the degree of oscillation of the differential pressure value, and the difference between the degree of oscillation of the pressure value on the low pressure side and the degree of oscillation of the differential pressure value.

As a result, according to Claim 1, it becomes unnecessary to carry out a regular inspection of a clogging state of a pressure conducting path, and it becomes possible to reduce the work units for maintenance. In addition, since it becomes possible to make a clogging diagnosis at a necessary time to a necessary degree, the reliability of a pressure measurement improves. In addition, many years' experiences have been required in order to presume a clogging state of a pressure conducting pipe from an abnormal output of a pressure measuring apparatus, but if use is made of the apparatus in accordance with the present invention, it becomes possible for anyone to make a diagnosis. According to Claim 2, if one obtains a difference between a static pressure value and a differential pressure, it becomes possible to clarify a clogging state /states of a



pressure conducting pipe / pipes which can be made clear in accordance with Claim 1. Because of this, a more accurate diagnosis becomes possible in a more convenient manner when presuming it. According to Claim 3, in a case in which clogging of a pressure conducting pipe is actually to be presumed, if it is presumed only from a variation of the width of oscillation, there is a possibility that one may make an erroneous presumption of clogging in spite of a fact that there is no clogging, because the width of oscillation of a differential pressure and a static pressure varies, depending on the flow volume condition which is being measured. In addition, in order to avoid this, it is necessary to attach various conditions to the correlation, and thus it becomes complicated to presume clogging. By the signal processing in accordance with the invention of Claim 3, it becomes possible to presume a clogging state more simply. Therefore, in accordance with the present invention, it becomes possible to provide a pipe clogging detecting apparatus by which to detect clogging in a pressure conducting pipe, for which the reliability of a pressure measurement can be improved, and maintenance

is simple and easy.

[Simple Explanation of the Drawings]

[Fig. 1] is a drawing by which to explain the constitution of the major section of one example embodying the present invention.

[Fig. 2] is a drawing by which to explain the operations of Fig. 1.

[Fig. 3] is a drawing by which to explain the operations of Fig. 1.

[Fig. 4] is a drawing by which to explain the operations of Fig. 1.

[Fig. 5] is a drawing by which to explain the constitution of the major section of another example embodying the present invention.

[Fig. 6] is a drawing by which to explain the operations of Fig. 5.

[Fig. 7] is a drawing by which to explain the constitution of the major section of another example embodying the present invention.

[Fig. 8] is a drawing by which to explain the operations of Fig. 7.

[Fig. 9] is a drawing by which to explain the operations of Fig. 7.

[Fig. 10] is a drawing by which to explain the operations of Fig. 7.

[Fig. 11] is a drawing by which to explain the constitution of the major section of another example embodying the present invention.



[Fig. 12] is a drawing by which to explain the constitution of an conventional example which has been generally used for many years.

[Explanation of the Symbols]

11 object for measurement

12 orifice,

13 pipe,

14 a pressure conducting pipe,

14 b pressure conducting pipe,

15 differential pressure detecting device,

16 differential circuit,

17 memory circuit for pressure data,

18 circuit by which to calculate the degree of pressure oscillation,

19 correlation calculation circuit,

21 correlation recording circuit,

22 clogging diagnosis circuit,

23 clogging diagnosis result signal

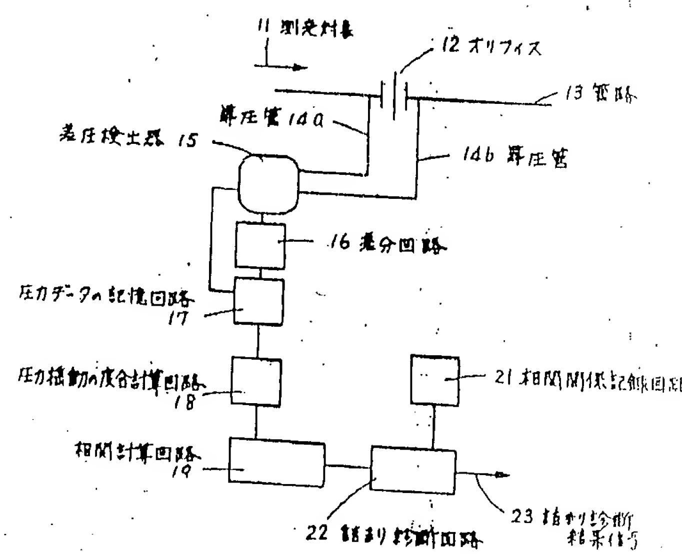
31 clogging diagnosis circuit

41 clogging diagnosis circuit

51 clogging diagnosis circuit

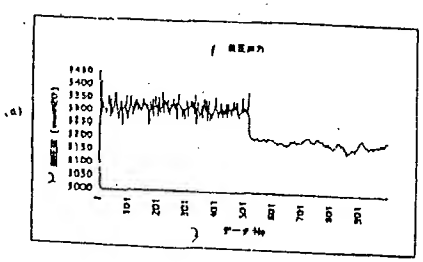


[Fig. 1]

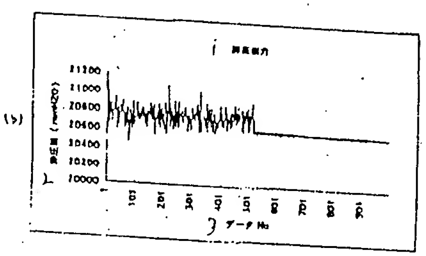



Key 11 object for measurement, 12 orifice, 13 pipe, 14 a pressure conducting pipe, 14 b pressure conducting pipe, 15 differential pressure detecting device, 16 differential circuit, 17 memory circuit for pressure data, 18 circuit by which to calculate the degree of pressure oscillation, 19 correlation calculation circuit, 21 correlation recording circuit, 22 clogging diagnosis circuit, 23 clogging diagnosis result signal

Fig. 2

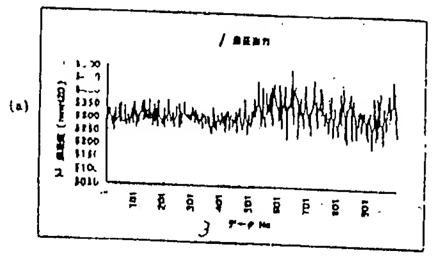


key 1 differential pressure output
2 differential pressure value, 3
data No.

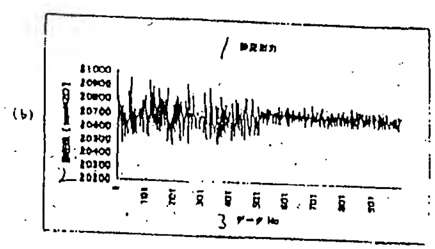


key 1 static pressure output
2 static pressure value, 3
data No.

Fig. 3



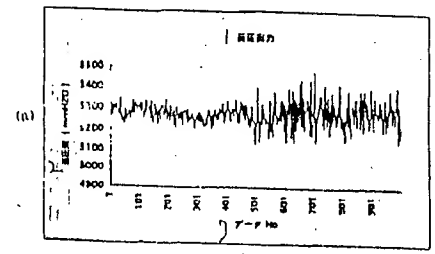
key 1 differential pressure output
2 differential pressure value, 3
data No.



key 1 static pressure output
2 static pressure value, 3
data No.



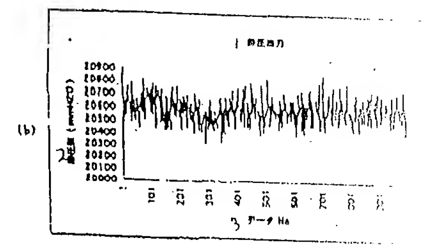
Fig. 4



key 1 differential pressure output

2 differential pressure value, 3

data No.

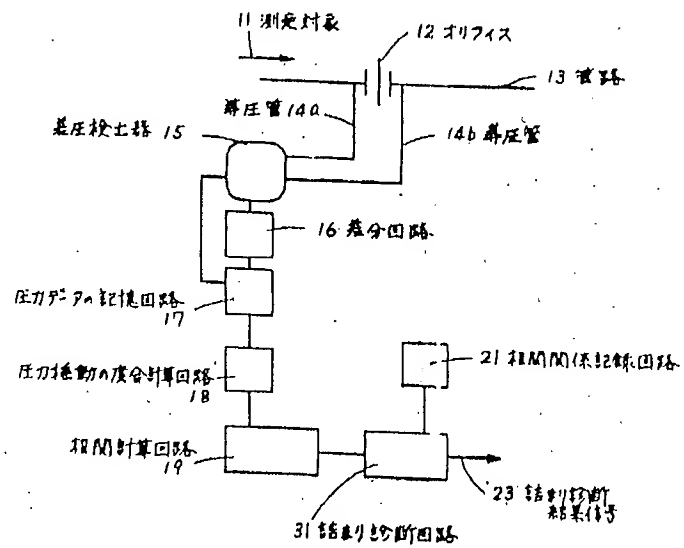


key 1 static pressure output

2 static pressure value, 3

data No.

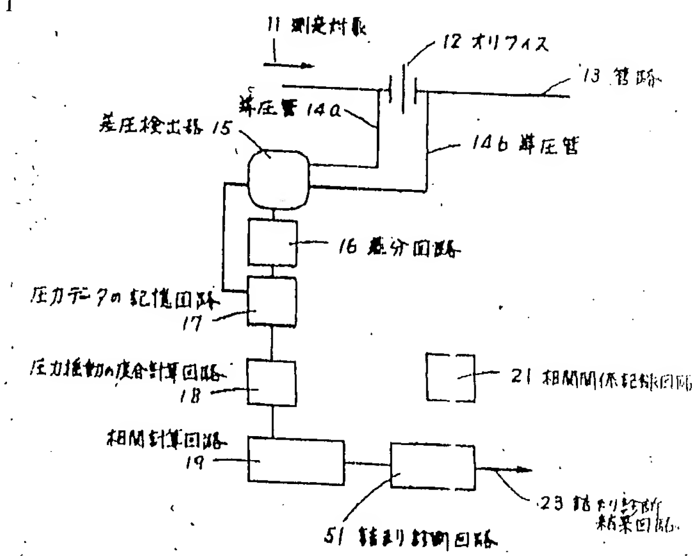
Fig. 5




Key 11 object for measurement, 12 orifice, 13 pipe, 14 a pressure conducting pipe, 14 b pressure conducting pipe, 15 differential pressure detecting device, 16 differential circuit, 17 memory circuit for pressure data, 18 circuit by which to calculate the degree of pressure oscillation, 19 correlation calculation circuit, 21 correlation recording circuit, 23 clogging diagnosis result signal, 31 clogging diagnosis circuit

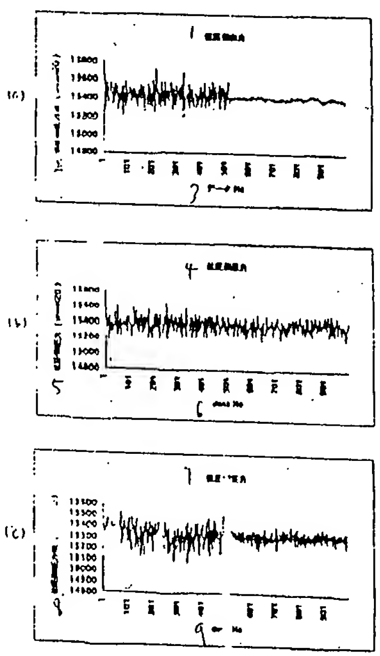


Fig. 11




Key 11 object for measurement, 12 orifice, 13 pipe, 14 a pressure conducting pipe, 14 b pressure conducting pipe, 15 differential pressure detecting device, 16 differential circuit, 17 memory circuit for pressure data, 18 circuit by which to calculate the degree of pressure oscillation, 19 correlation calculation circuit, 21 correlation recording circuit, 23 clogging diagnosis result circuit (sic), 51 clogging diagnosis circuit

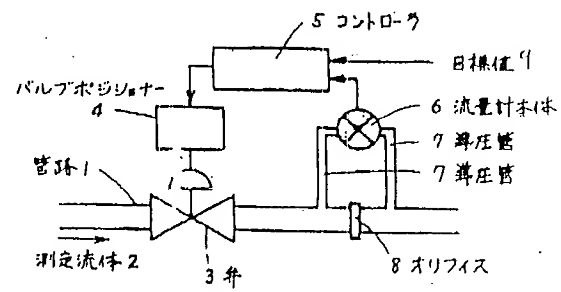
[Fig. 6]



1 pressure on the low pressure side, 2 pressure value on the low pressure side 3 data No., 4 pressure on the low pressure side, 5 pressure value on the low pressure side, 7 pressure on the low pressure side, 8 pressure value on the low pressure side, 9 data No.

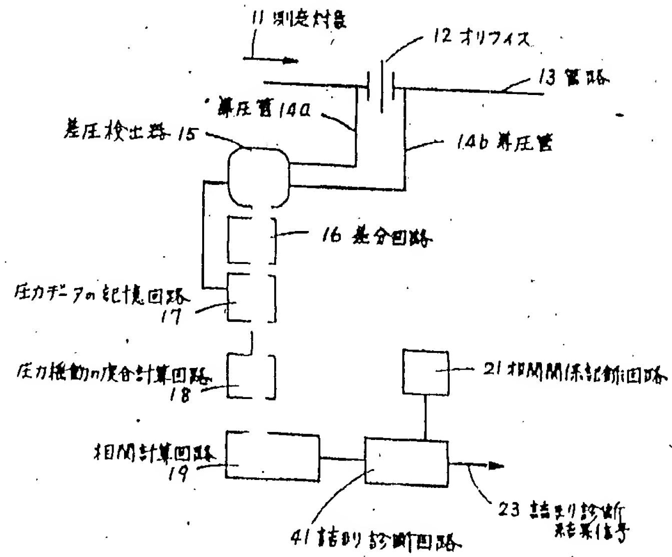


[Fig. 12]




key 1 pipe path, 2 fluid to be measured, 3 valve, 4 valve positioner, 5 controller, 6 flow meter body, 7 pressure conducting pipe, 8 orifice, 9 target value

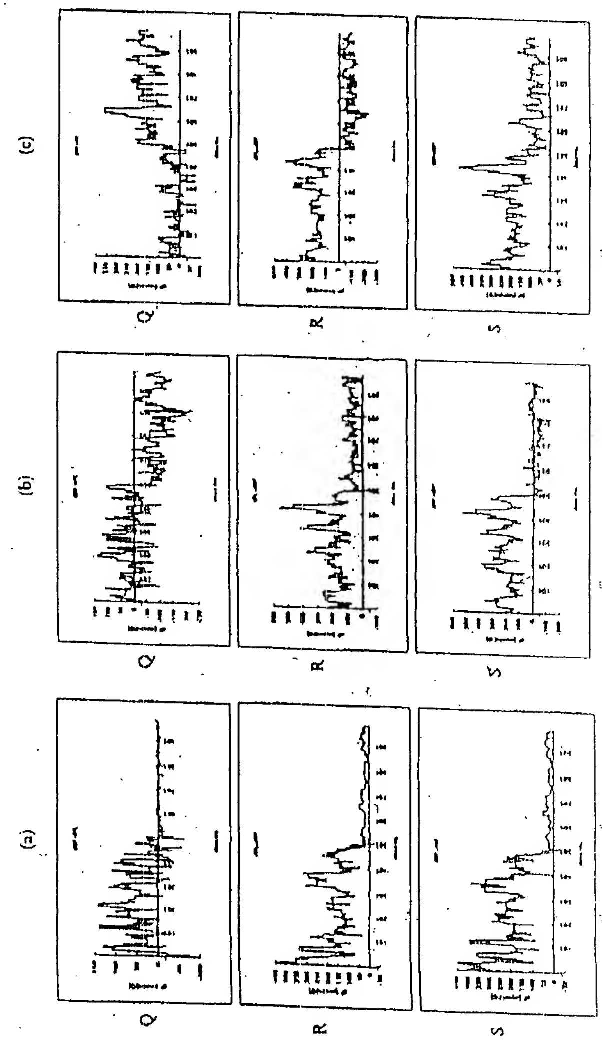
[Fig. 7]



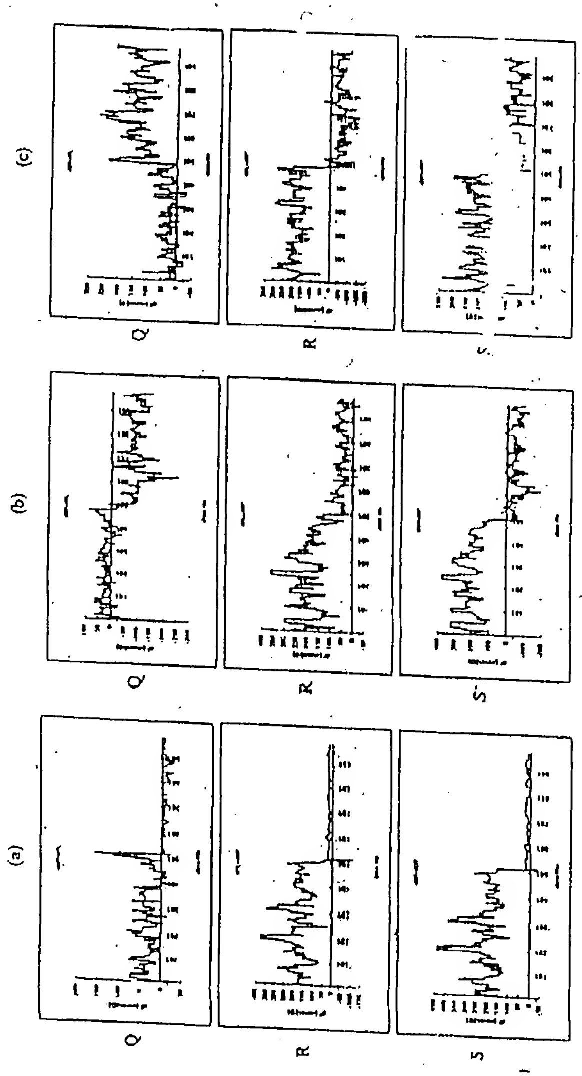

Key 11 object for measurement, 12 orifice, 13 pipe, 14 a pressure conducting pipe, 14 b pressure conducting pipe, 15 differential pressure detecting device, 16 differential circuit, 17 memory circuit for pressure data, 18 circuit by which to calculate the degree of pressure oscillation, 19 correlation calculation circuit, 21 correlation recording circuit, 23 clogging diagnosis result signal, 41 clogging diagnosis circuit



[Fig. 8]

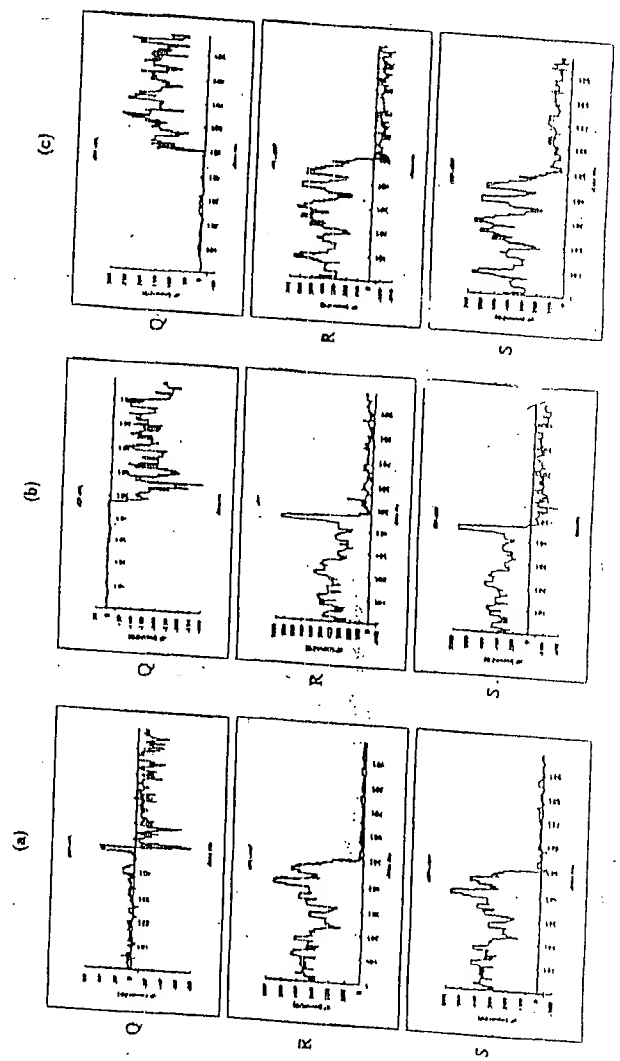


[Fig. 9]






[Fig. 10]



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